AUTORE
Automotive deRivative Energy system

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Programme Review Days 2018

Brussels, 14-15 November 2018

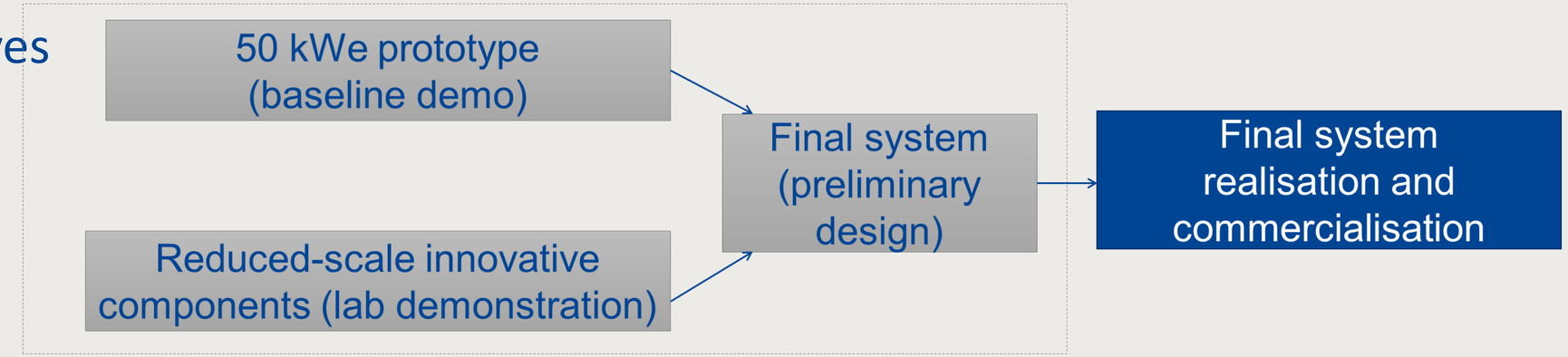
PROJECT OVERVIEW

- **Call year:** 2014
- **Call topic:** FCH-02.5-2014 – Innovative fuel cell systems at intermediate power range for distributed combined heat and power generation
- **Project dates:** 01/08/2015 – 30/04/2019
- **% stage of implementation 01/11/2018:** 87%
- **Total project budget:** 4,464,447€
- **FCH JU max. contribution:** 3,496,947€
- **Other financial contribution:** 796,850€
- **Partners:** Alstom Power Ltd (100% GE-owned), General Electric (Switzerland), Daimler AG, NuCellSyS, Helbio, University of Split, Tuscia University, SINTEF

PROJECT SUMMARY

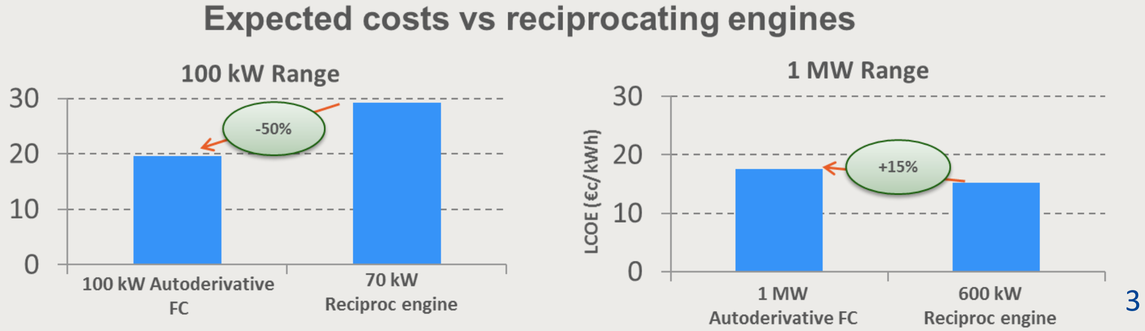
AutoRE, Automotive deRivative Energy system

- Objectives



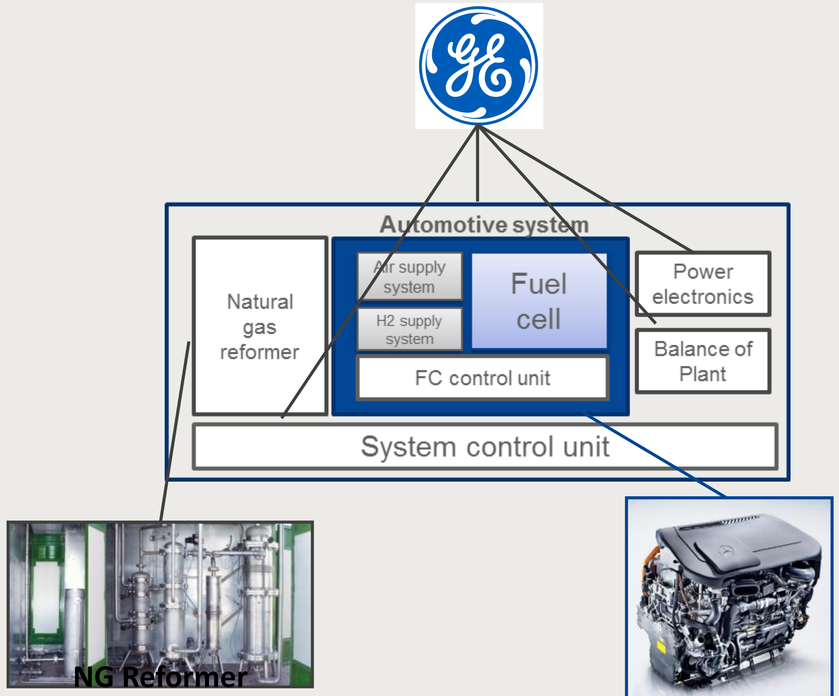
- Global positioning vs **international state-of the art**
  - Apparently no commercial systems in the 50-100kWe size range

- Application and market area
  - combined heat and power (CHP) in commercial/industrial buildings at 50-100kWe size



PARTNER ROLES

50 kWe baseline demo in Rugby



Gas reformer:

Helbio Hydrogen & Energy Systems

DAIMLER

FC automotive system:

NUCELLSYS THE FUEL CELL SYSTEM COMPANY

Innovative, Lab-scale and desktop activities

- Pd-based membranes for H_2 purification: SINTEF (lead)

SINTEF

- Fuel cell stack operated on reformate: NucellSys+Helbio (lead)

Helbio Hydrogen & Energy Systems

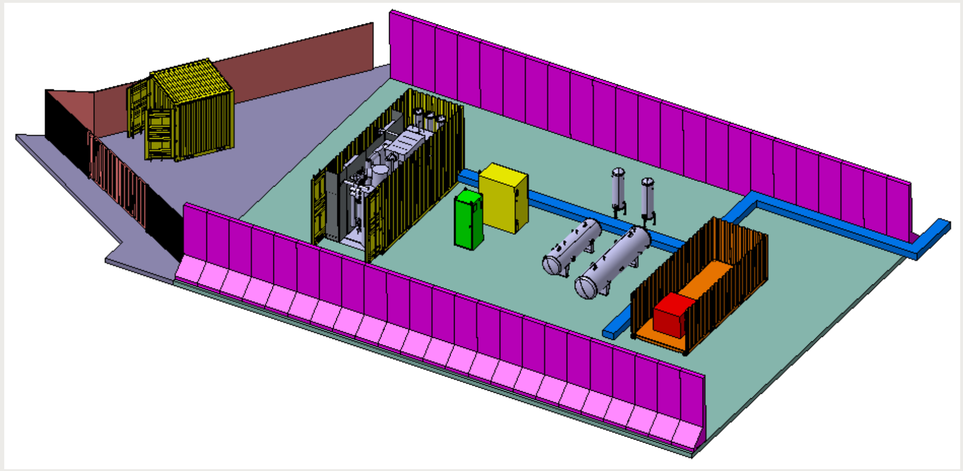
NUCELLSYS THE FUEL CELL SYSTEM COMPANY

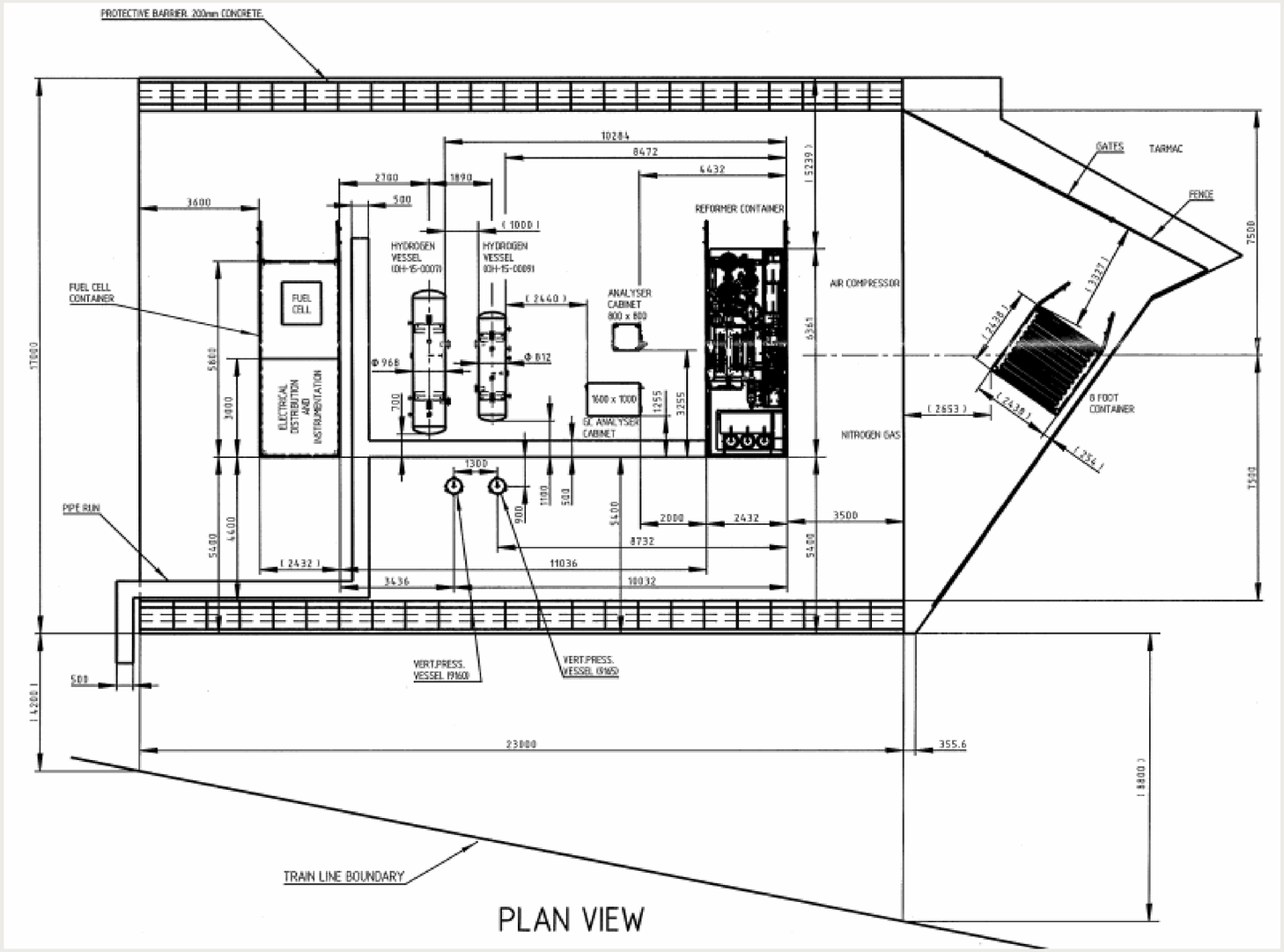
- Modelling, diagnostic and RAMS: Univ. Split-FESB, Univ. Tuscia, GE

FESB

UNIVERSITÀ DEGLI STUDI DELLA Tuscia

PROTOTYPE TEST FACILITY – layout





PROTOTYPE TEST FACILITY – in ‘real-life’

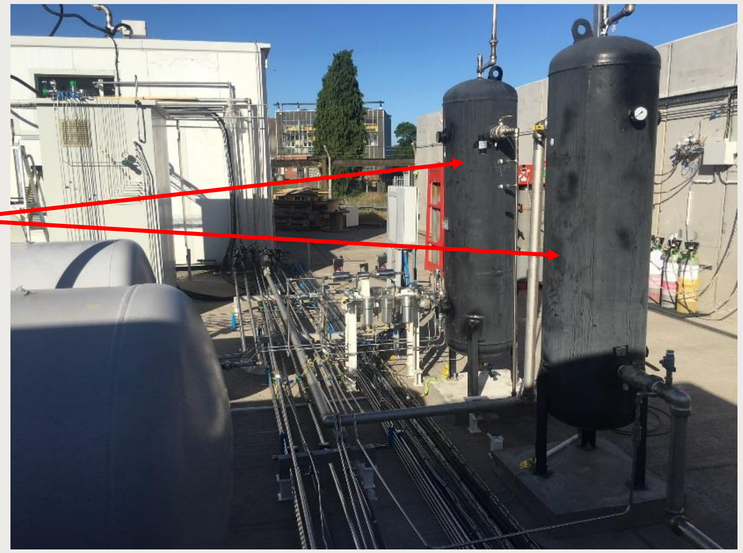
Natural gas reformer

Fuel-cell container

H2/tailgas tanks

Gas analysers and chromatograph

Natural gas storage tanks



PROJECT PROGRESS/ACTIONS – Efficiency

Achievement to-date

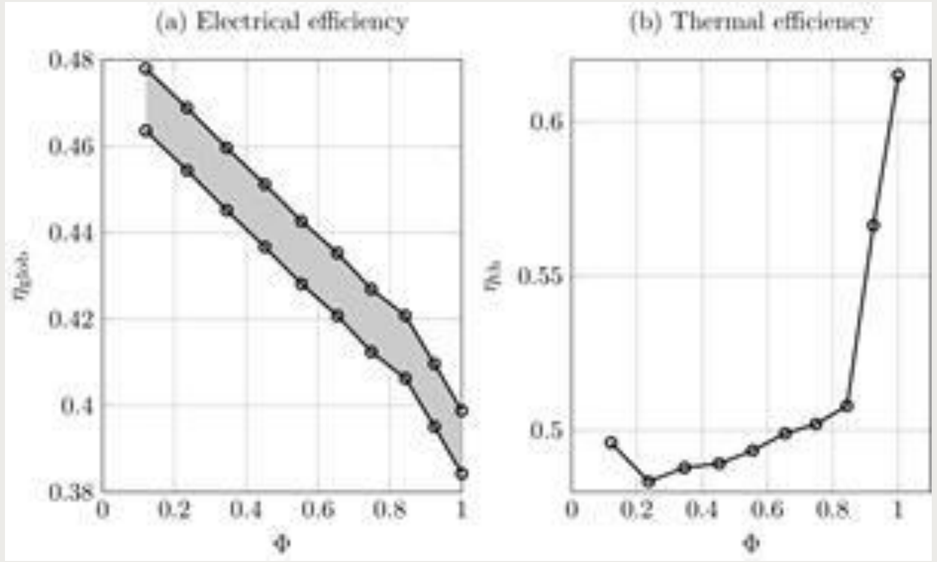
Electrical Efficiency of 38-40% LHV

25% 50% 75%

Electrical Efficiency of 46% LHV

Initial values to be confirmed through the 50 kW ‘baseline’ demonstration

Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Efficiency	Electrical efficiency	%LHV	35%-43%	46%	42-55%	42-55%
	Total efficiency	%LHV	80%	82%	NA	NA



Efficiency as a function of loading

PROJECT PROGRESS/ACTIONS – Stack life-time

Achievement to-date

Life-time 6kh (automotive cycle)

25% 50% 75%

Life-time 30kh

Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Stack life-time	Life-time	Hours	20,000	>30,000	NA	NA

- Durability of automotive stack in stationary applications is unknown
- Experience with bus driving cycles allows for expecting >30,000 hours

Future steps:

- 'Early' degradation data from the 50 kW "baseline" prototype
- Utilize proprietary degradation models to estimate life-time in stationary applications

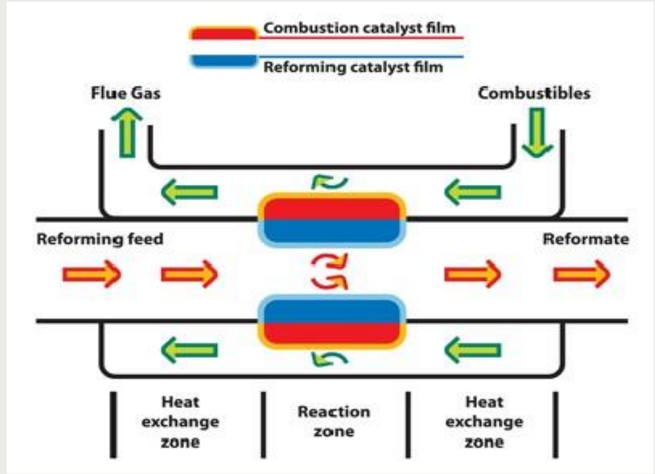
Risks and Challenges

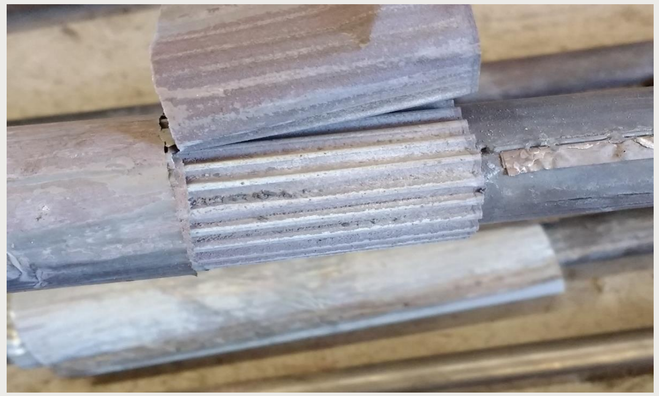
Main bottleneck has been design/delivery of NG reformer (Task 3.1./3.3)

- Helbio initial build 6 months delayed to end of June 2017 (M23) due to upscaling task more complex than originally foreseen and sourcing of 347H steel longer than expected
- Commissioning at Helbio site revealed high reactor dP due to material choice for reformer tubes delaying delivery to Prototype test site until May 2018 (M34)
- 9 month contract extension to complete 3000h endurance test
- 3000h test started 1/10/18 but further issues with a fuel processor peripheral delayed restart to w/c 12/11/18

Additional issues due to GE acquisition of Alstom Power

- Reassignment/cancellation of project tasks eg RAMS and compact heat exchanger
- Modification of exploitation plan





Fe corrosion products blocking reactor tubes

Communications Activities

Project communication via :

Workshops/Conferences and Papers

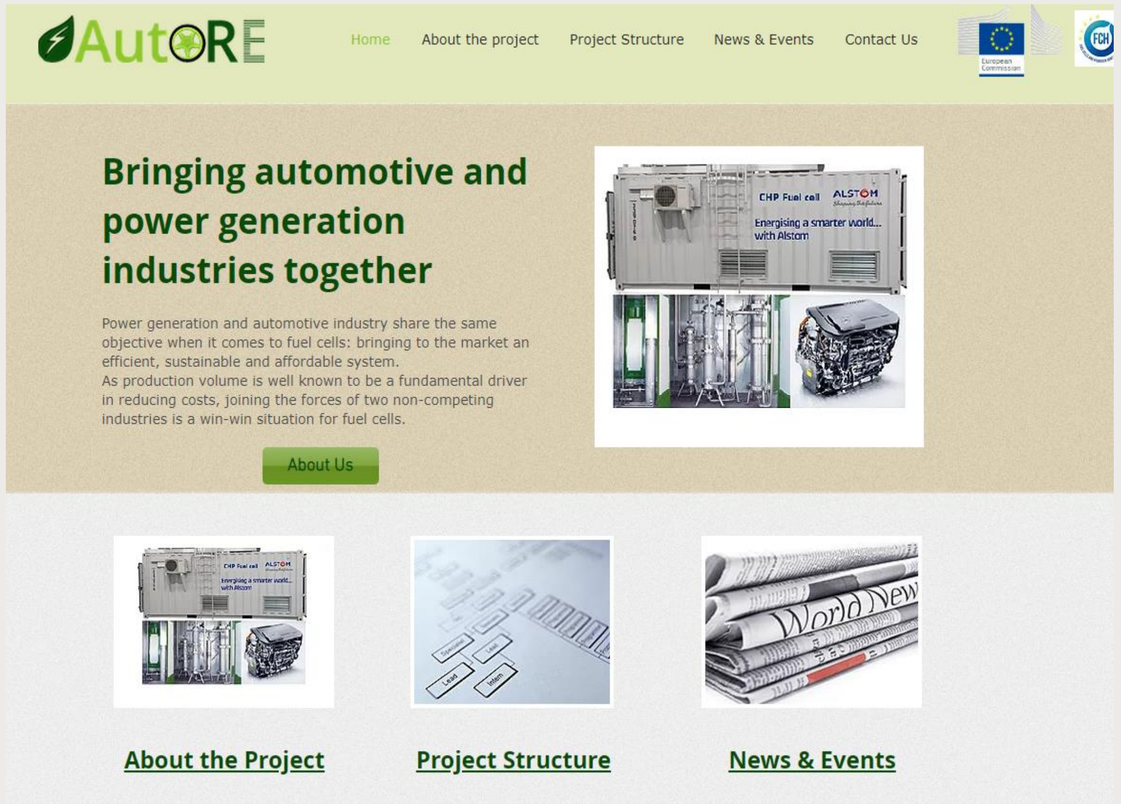
- >25 project related publications to date (see Project website for details/links)
- AutoRE project workshop scheduled towards end of project when prototype results available

Project specific website

- https://www.autore-eu.com/

Local press release initiatives

- "Helbio announce delivery of H2 system for AutoRe project" http://www.helbio.com/assets/Uploads/Press%20Release_Helbio%20AutoRE%20_April%202018v.pdf
- "University of Tuscia at forefront of future of energy in Europe" https://www.ontuscia.it/societa/universita-della-tuscia-272106 https://etruriaoggi.it/universita-della-tuscia-in-prima-linea-nel-futuro-dellenergia-in-europa/



EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation

Exploitation to follow the strategy defined in Exploitation Plan

- Focus on business partners Helbio and NuCellSys/Daimler to exploit components of the system (stack and natural gas reformer)
- SINTEF has signed a license agreement with Hydrogen Mem-Tech AS in Norway for further upscaling and commercialisation of Pd-based membranes

SSERR: Support Service for the Exploitation of Research Results web-link sent to AutoRE partners

Expected Impacts

Technical impacts

- Electrical efficiency: 47%
- Thermal efficiency: >43% (90% electrical plus thermal efficiency)
- Stack life-time: >30,000 hours
- System CAPEX: <3,000 €/kW, allowing grid parity
- Scheduled/preventive maintenance to reach >98% availability, and no unforeseen shut-down for at least 2 years

Business opportunities and job creation

Improving innovation capacity

Regulations, codes and standards (RCS), and related best practice procedures

- Public domain deliverable on permitting ‘lessons learned’

Benefits for the environment and European security of supply

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